

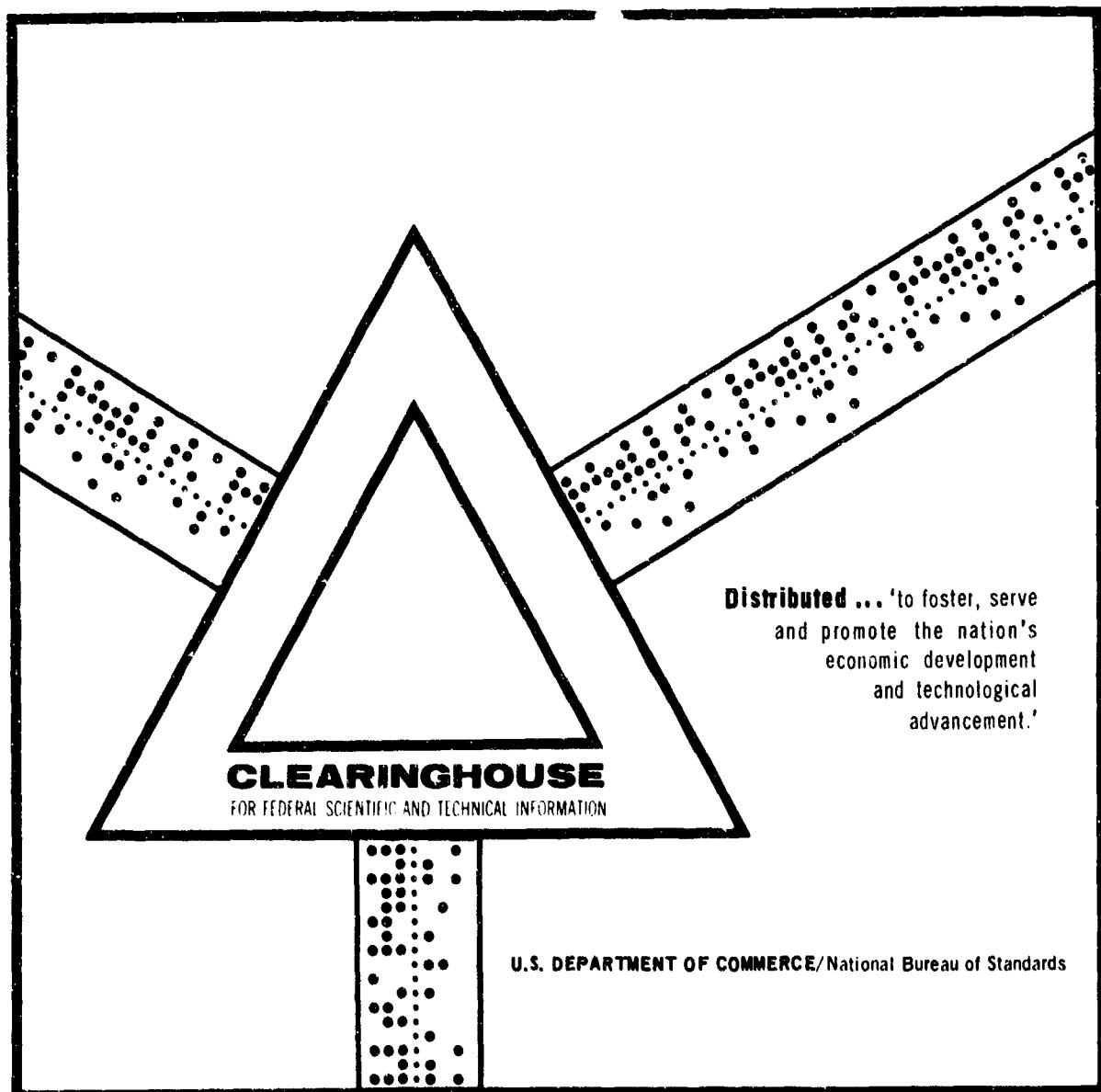
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THE AUTOMOBILE'S ROLE IN THE FUTURE

John L. Hult

Rand Corporation
Santa Monica, California

March 1970



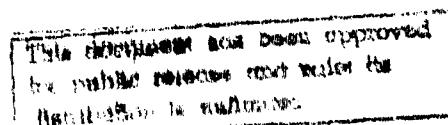
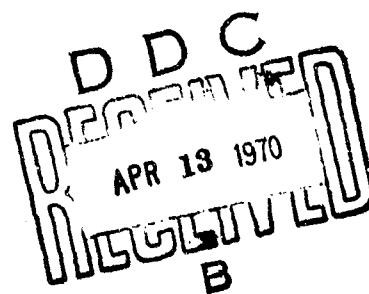
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John L. Hunt

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PREFACE

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THE AUTOMOBILE'S ROLE IN THE FUTURE

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ABSTRACT

This paper explores the competition between various modes of travel as a function of range and between travel and electronics for communicating. An evolutionary development of our means of travel is described which would introduce new concepts for improving the capacity and capability of our urban transportation systems while mollifying unwanted side effects. A Freeway Express Transit is outlined which would better use the already huge investment commitments in land, equipment, and social way of life that have made the automobile such an important factor. It would retain the eminent role of the automobile while evolving the transportation systems toward more socially satisfying means.

INTRODUCTION

The automobile has become a prominent factor in our physical environment and in our way of life. Its unfettered proliferation with our population to urban centralization has compounded congestion and environmental degradation until we are distressed with the transportation performance and find unacceptable any further violation of the environment. We thus need to find a way to handle a growing population of automobiles in a manner that will enable better performance and less environmental degradation. This paper addresses this problem and outlines the following: a proposed automated urban local transportation utility that would relieve local urban transportation deficiencies; a proposed Freeway Express Transit that offers evolutionary solutions for rapid transit and urban express transportation needs; and air transit that would be integrated into the shorter range ground transportation networks to satisfy the most pressing interurban and long distance travel needs. In addition, the competition between travel and electronics for communications is assessed. By taking all these factors into account together with potential developments of the automobile (see Appendix A), a possible future role of the automobile in our society is developed.(1)

^{*}Any views expressed in this paper are those of the author. They should not be interpreted as reflecting the views of The Rand Corporation or the official opinion or policy of any of its governmental or private research sponsors.

LOCAL URBAN

In urban areas much travel is for a large variety of short local errands, requiring individual choice of time, origin, and destination. A private automobile (frequently second or third car) satisfies much of this need, even though it is being used only a small fraction of the time. However, this mode of travel requires a driver for every errand and is not readily available to independent nondrivers. Conventional mass public transportation does not provide the personal choice of time and destination. Small vehicles available at the convenience of the individual are needed, e.g., taxis in adequate supply. However, the latter are not economically acceptable for much of the potential need because of the relatively large driver costs. For the small vehicle to be justifiable economically, it should be automated. Then it could be used by anyone for transporting anything—children, the blind, groceries, mail, garbage, and public safety surveillance equipment. This might be accomplished and the charge recorded as simply as dialing a telephone circuit.

If automation is to be feasible, the system must operate on its own exclusive guideways. In many urban areas these guideways might be most acceptable as overhead hanging systems above alleys or sidewalks. They could form a network of interconnected one-way loops covering residential and business districts and also serve as collection and distribution systems for terminals of longer range public transportation. Such a system might typically serve an area five miles in diameter, with a central computer routing the trips for greatest system efficiency. Large metropolitan areas could be served by many such closed systems. The electrically powered vehicles could be distributed throughout each system by the computer to best meet the anticipated needs.

Local transportation utilities could be developed and operated by private enterprise or on a community cooperative basis. The capital investment in the vehicles for widespread use should be less per vehicle than for automobiles, and the number of vehicles needed should be less than ten percent of the number of second cars that they would replace, because of the small average use per family. Also, many automated errands would be only one-way, not requiring that the vehicle return, or with the other way satisfied by electronic communications. Thus with a high enough density of users the savings in capital investment for vehicles should be adequate to compensate for the investment in guideways and central computers. The operating costs of the

transportation utility should be considerably less than those of private cars in terms of fuel or energy consumed, maintenance, parking and storage costs, and insurance and taxes. Thus the intrinsic cost of the services provided by the transportation utility in a high density environment should be less than that of private automobiles, and a considerably greater range of attractive service capabilities would be available.

The greatest obstacle to the development of such transportation utilities may be the first operational entry. If the first community to try the system must bear the full development and acceptance testing costs, it may never be tried. The most attractive possibility for introducing the system would be a Federal Government subsidy of the system design and development in a new community, where all the utilities and right-of-ways could be integrated into the community design at the outset. Once a system has been developed and accepted, there should be no problem in introducing it into established communities.

URBAN EXPRESS

The concept of a Freeway Express Transit is oriented around an environment of which Los Angeles is typical, where investment in and commitment to the automobile and a comprehensive freeway network must be considered in any new transportation system. Preliminary exploration indicates that a Freeway Express Transit could use freeway network right-of-ways to provide additional exclusive guideways for rapid express train service for toll-free transportation of cars, people, and goods with the following tentative claims:

- o It would relieve freeway congestion and increase the capacity and quality of service to a growing population of cars more effectively and at less cost than by adding conventional freeway capacity.
- o It would provide a similar, comprehensive, toll-free transit service for people and goods at less cost than that required to provide poorer quality rapid transit service alone by conventional methods.
- o It could be introduced in an evolutionary way, adapting to the changing demands for transportation services for cars and/or people and/or goods.
- o It would relieve air pollution, fuel consumption, accidents, and automobile wear-out.
- o It would relieve parking problems and land consumption in central business districts while accommodating the increased population of cars.
- o It would demand no new right-of-way land, nor would it further degrade the adjacent environment beyond the effects of the freeways.
- o It offers an attractive means of financing without a separately visible or identifiable tax burden.

If any significant portion of these tentative claims

still holds after detailed design and application of the system to a specific environment, serious consideration for adoption of the system would seem justified.

In order to offer a transit service competitive with driving on the freeway, it will be necessary to provide high speeds with frequent schedules and short dwell times at stations. Train cruising speeds of 75 to 90 mph, maximum accelerations of 3 mph/sec, and station dwell times of 30 sec would provide average speeds including stops of greater than 60 mph for distances between stations of 5 to 10 mi. This is typical of the distances between freeway interchanges in the Los Angeles area when the planned network is completed, and stations near freeway interchanges would provide convenient sources, sinks, and exchanges of traffic. The minimum headway required between trains would be between 60 and 90 sec.

In order to exceed the conventional freeway capacity in throughput of cars per roadway area, it will be necessary to pack the cars on the trains tightly and to use long trains. If the cars were driven onto the trains crossways on two decks, trains 700 ft long would exceed the capacity of a four-lane freeway and require much less roadway. However, this capacity of traffic is beyond any reasonable means of collecting and distributing cars with on- and off-ramps at one station. A more practical scheme would automatically load the vehicles with conveyor belts onto conventional sized single deck railroad cars from the sides so that they are aligned in the direction of travel. Such trains up to 1000 ft in length could exceed the capacity of one freeway lane with less roadway requirement. The station on- and off-ramps and traffic sources and sinks are easily handled at this traffic level, even if there is a complete unloading and loading at every station stop. The latter operation seems more practical than allowing through traffic and attempting to control the loading spaces by computer to correspond with empty slots when using quick automatic unload and load procedures.

The train roadbed might be elevated with posts on the freeway center divider supporting a two-way system. Greater capacity could be achieved by adding similar systems on each side of the freeway. Each train lane would be served by separate stations raised high enough above the freeway to clear other train and freeway traffic.

The Freeway Express Transit would augment the freeway capacity with train transportation, allowing greater automobile flow per unit of roadway area than the conventional freeway. No special guidance or other modifications to existing automobiles would be required, and the Freeway Express Transit would be much less hazardous than proposed methods⁽²⁾ for individually controlling each vehicle at high speeds and short headway spacings.

It would be desirable to develop auto parking spaces on freeway right-of-ways in the vicinity of most stations. These parking spaces and the stations could be served by a frequent schedule of low-profile toll-free minibus trains to enable free

exchange of people and goods between stations and parking areas. Business districts might support, as part of their parking requirements, such toll-free minibus service within the district as well as connecting Freeway Express Transit stations, associated parking, and other public transportation systems. Thus toll systems such as conventional buses or taxis could provide access to the toll-free system by contact with the minibus stream at any point.

The Freeway Express Transit provides a simple expansion of the freeway system, and as part of this system it should have a legitimate claim for construction support from highway funds. The new development costs might be supported out of Federal funds. The fact that the system may involve a conflicting jurisdiction of interest among government agencies should not be allowed to confuse or delay action in its support.

The operating expenses and any costs peculiar to the transporting of people and goods would have a justifiable claim to the revenues derived from an antipollution tax (see Appendix A). Parking space and toll-free minibus service for business districts should receive support from parking authority assessments, as prorated within the district to meet parking requirements. Thus, the financing of the development, construction, and operation of a toll-free Freeway Express Transit system would seem feasible without special legislation.

INTERURBAN AND LONG DISTANCE

The Freeway Express Transit system, when combined with conventional systems and suitable methods for the local collection and distribution of goods and people, such as buses, personal vehicles, or automated urban local transportation utilities, might provide a satisfactory basic intraurban transportation network for a long time into the future.

If airports can be suitably integrated into the intraurban transportation networks, the dominant mode of interurban travel for distances of more than 100 to 300 miles will probably be by air. It seems very unlikely that any of the fixed-guide-way techniques, requiring huge capital investments to provide time and schedule performances comparable with those possible by air, could successfully compete with air for the dominant role in long-range travel in our rapidly developing and changing society.

TRAVEL OR ELECTRONICS FOR COMMUNICATIONS

Much current travel is specifically or primarily for communicating. As we develop more competent and comprehensive means of communicating electronically we can legitimately ask, How much of our communicating can we do and may we choose to accomplish electronically? It is becoming clear that technology will soon be able to provide electronic communication that will be faster, more effective, and more time and cost efficient than that possible by travel.⁽¹⁾ We should therefore expect that sig-

nificant future travel, done specifically to communicate, may be replaced by better electronic communications.⁽³⁾ However, if the transportation industry can provide vehicles with adequate environment control and communication access, and if we can develop more complete communication facilities available everywhere, new types of travel might be appealing and feasible while still providing more effective global communication contact for business, government, education, and recreation. This approach would take advantage of the technological potential for electronic communications to provide new opportunities for travel, rather than focusing concern on the competition between electronics and travel for communicating.

SUMMARY AND CONCLUSIONS

The future of travel and the automobile is explored, including the competition among the various modes of travel and (if the travel is primarily to communicate) between travel and electronics for communicating. With vigorous further development, the automobile is likely to continue its domination of short-range (i.e., < 100 mi) land travel. However, it may be complemented by new forms of travel in some urban areas, i.e., Freeway Express Transit and automated local transportation utilities. The latter two forms of travel show sufficient promise for alleviating many of the current urban transportation deficiencies that they warrant serious consideration for local action and Federal support of development and application to those urban areas where studies indicate the greatest promise. Air travel is likely to be the dominant mode for longer range travel.

It is becoming clear that technology will soon be capable of providing electronic communication that will be faster, more effective, and more time and cost efficient than that possible by travel. We should therefore expect that significant future travel specifically to communicate may be replaced by better electronic communications. However, if we can provide vehicles with adequate communication access, we could make available new opportunities for travel while still providing more effective, global, electronic communication contact for business, government, education, and recreation.

APPENDIX A: SOME IDEAS ABOUT FUTURE AUTOMOBILES

This appendix provides a casual listing of some ideas for future automobiles to illustrate the rich variety of possibilities that is available to meet challenges that may develop. There is no attempt to identify those that might be socially or economically viable.

SAFETY

Safety in automobile travel may be linked to three principal groups of factors: vehicle design, roadway design and traffic environment, and the human factors and risk psychology. Only some sample ideas in the first area will be given here; however, their

effect might be limited without improvements in the other two areas.

Stopping and Shock Absorption

A critical factor in auto safety is the ability to decelerate with minimum damage. This is the opposite of the measure of performance in drag racing, where it has been possible to achieve more than 1.5 g of acceleration by effective road-tire contact. A comparable performance in stopping might be approached with wide-tread contacts, rotating (non-locking) wheels, and stable nonsteering front suspension. The latter arrangement could be used to eliminate the principal contribution to tire wear—conventional front wheel alignment and suspension. In addition, it would provide an opportunity to use the potential of the front tires to absorb the shock of frontal collisions. The steering could then be accomplished with a single third suspension in the rear, properly instrumented and coupled to the controls to ensure steering stability at any speed. With dual tires at each suspension point, it would be possible to "wear the spare" and ensure complete reserve-tire capability and redundancy.

Controls and Body Restraints

Conventional automobile controls have not been designed to minimize the mechanical feedback of vehicular accelerations through the driver to the controls. If the critical controls for steering, stopping, and acceleration were designed for dual redundant wrist controls with forearms anchored to secure armrests, the driver would be free to brace himself with the rest of his body or adjust himself to alleviate fatigue, and the secure forearm anchors could provide a more effective body restraint than conventional seat belts. Passengers might find sideways seating, with vertical net partitions between them as automatic restraining mechanisms, more effective and acceptable than the conventional straps and harnesses that frequently degrade comfort and convenience and often are not used.

Miscellaneous Safety Factors

It should be possible to improve the visibility in all traffic directions and from all positions within the automobile by the appropriate disposition of windows, mirrors, and controllable glare-reducing blinds, no matter where the driver is located. In addition, improved external direction- and speed-signaling with better internal monitoring should contribute to greater operating safety. With a rear suspension that is capable of being swiveled adequately, complete parking articulation would be possible, permitting safer and more efficient use of parking space. In addition, with exit and entry conveniently accessible at the curbside, and with doors that do not swing out to threaten traffic or the finish of an adjacent parked car, many parking safety problems and annoying damage could be avoided.

PERFORMANCE

The traditional performance features of the auto-

mobile are its mechanical power, safety, and control. While these should continue to be important, other of its attributes—such as complete access to private communication and broadcast networks, and to precision navigation and positioning systems to warn of threatening collisions and to provide a variety of location services—should become increasingly valuable. Also, complete environment control is a growing need, including temperature control, air conditioning with detailed control of its composition and distribution, and noise and light control aided by a greater use of fixed glazing.

With superior environment control and complete access to private communication and broadcast networks, the automobile would become a very attractive addition to the home for a variety of functions, especially if it could be connected to the home's electrical power to operate needed auxiliary equipment. In this way, the automobile could be made a versatile, multipurpose facility with more uses to justify its greater expense.

AIR POLLUTION

The automobile's contribution to air pollution has become a serious problem, for which no satisfactory solution may be forthcoming with only modest adaptations of the internal combustion engine. Alternative nonpolluting power sources⁽⁴⁾ such as turbines or steam engines may be required; if they are, it may be possible to achieve additional benefits in improved safety and performance that would help to justify the expected increased costs.

REGULATION

Government regulation of the use of automobiles could have an important influence on their further development and future use. In order to regulate the use of the automobile for the greatest general benefit of society, what and how to regulate need to be determined. In the case of air pollution, it is generally acknowledged that some kind of regulation is needed to gain control of this growing menace. The question of how to regulate it is the source of greatest controversy. The fairest way would seem to be to penalize or charge each car according to its contribution to air pollution. A convenient way to accomplish this would be to impose an air pollution tax on the sale of fuel in an amount proportional to the expected pollution produced per unit of fuel consumed, this rate to be standardized at a few values according to well-defined specifications of power-plant and air pollution control equipment. The yearly registration of the vehicle could certify the tax rate level. This method of regulation would impose the charge directly on the consumer, who would then influence the manufacturers by his choice of equipment.

A similar method of regulation might be used to control the safety of vehicle operation. A safety fuel tax could be imposed according to the proportion of the public safety budget for which the particular vehicle should be responsible. These levels of responsibility could be standardized to include a variety of equipment factors such as those now

required by law, e.g., seat belts, various safety lights, etc. New equipment factors might be included at some levels, such as speed lighting, which would indicate at a distance the speed range at which the vehicle is moving; radio communication access and identification to permit communication between vehicles and electronic identification of the driver; and action recording that would automatically maintain a record of the speed, control, and functioning of the vehicle for the last few miles of travel. In addition to the equipment factors, operational safety experience could be included at some tax level as desired. For example, a point system based on recent accidents and traffic violations, similar to that used to determine some insurance rates, could be used to impose a larger safety tax on fuel purchased.

In any type of regulation, it would be highly desirable to standardize it over as large an area as possible, i.e., at least nationally, in order to eliminate unnecessary confusion and artificial boundary exercises.

REFERENCES

- (1) Hult, J. L., "Communication Satellites and Their Possible Influence on the Automobile," The Rand Corporation, P-4164, August 1969.
- (2) "Megalopolis Transportation--A Special Report," Space/Aeronautics, Vol. 48, No. 4, September 1967.
- (3) "Telecommunications for Enhanced Metropolitan Function and Form," Report of the Committee on Telecommunications, National Academy of Engineering, August 1969.
- (4) Ayres, R. U., "Alternative Nonpolluting Power Sources," SAE Journal, Vol. 76, No. 12, December 1968, pp. 40-80.